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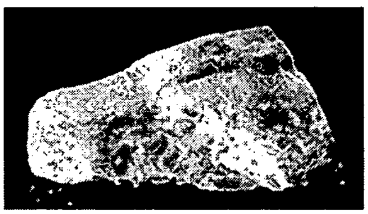
What is talc?



The term "talc" has four complementary meanings:

- Talc is a mineral: it is a hydrated magnesium silicate.
- Talc is a rock, it is known as steatite or soapstone. It is composed of varying proportions of the mineral talc often combined with other minerals (e.g. chlorite and carbonate)
- Talc is an industrial raw material in powder form, which is used as a commodity or speciality in a wide range of applications.
- Talc is a cosmetic powder. This is its most widely known application, even though it is one of the smallest in terms of consumption.

Geology & Occurrence

Talc deposits always result from the transformation of existing rocks under hydrothermal activity. Through this process, the components (MgO, SiO_2, H_2O) required for forming the parent rock into talc are brought by the hydrothermal water. The size and the geometry of the final deposit depend upon the size and nature of the parent rock, and the intensity and scale of the phenomenon. The geological context required for such a transformation to occur is known as a low to medium temperature and pressure metamorphism. Tectonic movements always play a major role: earth movements allow the hydrothermal fluid to penetrate

into the mother-rock, generating permeability that
makes reactions inside the rock mass possible. The surrounding pressure, either at the time of the transformation or later, determines the mineral's degree of lamellarity (low pressure/low lamellarity, high pressure/high lamellarity).

The nature of the mineralisation depends essentially on the nature of the parent rock. Several types of rocks can undergo transformation of this type, and so be the source of talc. Talc deposits are classified according to the parent rock from which they derive. There are four types of talc deposits:

Deriving from magnesium carbonates. This kind of deposit provides >50% of world production. It is found in ancient metamorphosed carbonate sequences. This talc is generally pure and white.

Deriving from serpentines. This type of deposit provides about 40% of talc supplies. The crude ore is always grey and, to be commercially viable, can be up-graded to improve mineralogy and whiteness (generally by flotation).

Deriving from alumino-silicate rocks. About 10% of world production is mined from these deposits. They are sometimes found in combination with magnesium carbonate deposits. The crude ore is generally grey due to the presence of chlorite (another phyllosilicate), but no up-grading is generally necessary as chlorite performs adequately in the applications of interest.

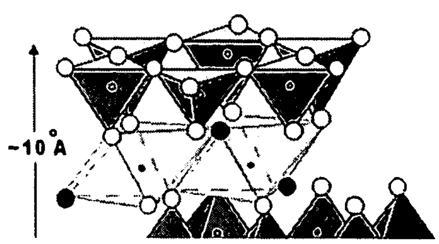
Deriving from magnesium sedimentary deposits. Talc is formed by direct transformation of magnesium clays. No such deposit is currently mined.

This wide diversity of origins and types of deposits naturally gives rise to a wide variety of ores and product grades, which differ according to their mineralogical composition, colour and crystalline structure (micro-crystalline or lamellar).

Additional information

Talc deposits worldwide
Talc deposits and operations in Europe

Physico-chemical properties



Talc is a natural mineral (chemical formula $Mg_3Si_4O_{10}(OH)_2$ - molecular weight 379.26). As shown in the opposite figure, its elementary sheet is composed of a layer of magnesium-oxygen/hydroxyl octahedra, sandwiched between

two layers of tetrahedral silica. The main surfaces, known as basal surfaces, of the elementary sheet contain neither hydroxyl groups nor active ions, making talc both hydrophobic and inert.

The size of an individual talc platelet (= a few thousand elementary sheets) can vary from approximately 1 micron to over 100 microns depending on the conditions of formation of the deposit. It is this individual platelet size that determines a talc's lamellarity. A highly lamellar talc will have large individual platelets whereas a microcrystalline talc will have small platelets.
The elementary sheets are stacked on top of one another, like flaky pastry, and because the binding forces (known as Van de Waal's forces) linking one elementary sheet to its neighbours are very weak, the platelets slide apart at the slightest touch, giving talc its characteristic softness.

Talc is odourless. It is insoluble in water and in weak acids and alkalis. Although talc has a marked affinity for certain organic chemicals, it generally has very little chemical reactivity. It is neither explosive nor flammable. Above 900°C, talc progressively loses its hydroxyl groups and above 1050°C, it re-crystallises into different forms of enstatite (anhydrous magnesium silicate). Talc's melting point is at 1500°C.

Talcs differ according to their mineralogical composition (i.e. the type and proportion of associated minerals present). The most common mineral found with talc is chlorite, which is structurally and chemically very similar. Dolomite and magnesite are also often present. As we have seen above, talcs also differ according to their degree of lamellarity.

People always think of talc as white but it can also be grey, green, blue, pink and even black.

Basically, talc is many talcs.

Organophylic properties

Talc shows an affinity for certain organic chemicals. It is therefore organophilic. In the case of talc's affinity for polypropylene, a likely explanation is that the position of the oxygen atoms on the surface of the talc platelet corresponds to the carbon bonds on the surface of the polypropylene crystal.

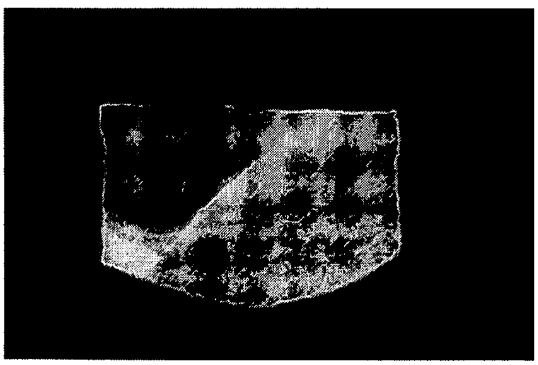
Talc's organophilic properties are used to great benefit in a number of applications: for instance, it helps polypropylene to crystallise. In papermaking, the talc particles attract the undesirable resin droplets (i.e. organic chemicals) in the pulp onto their surface. This is known as pitch control. In body powder applications, perfume is adsorbed onto the talc surface and retained.

Functions & Applications

The five main characteristics of talc that make it a unique material for industrial and domestic applications are:

* **Lamellarity (made of platelets that easily slide on each other)**
* **Softness (unctuous and not abrasive)**
* **Chemical inertness**
* **Affinity for organic chemicals**
* **Whiteness**

The main technical functions talc is used for are **anti-sticking, anti-caking, lubricant, carrier, thickener, strengthening filler, smooth filler, and absorbent.**

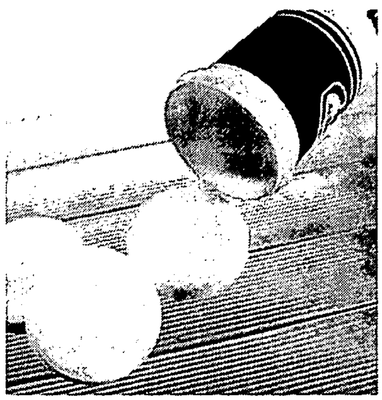


Anti-sticking

In many industrial processes, talc is used to prevent two materials from sticking together. Talc powdering of moulds is widely used, for example in tyre manufacture or foundry applications. Certain foodstuffs or conveyor belts transporting them are also powdered with talc, to excellent effect. Particle-wood boards (chip boards) are powdered in order to avoid them sticking when stockpiled.

Anti-caking

Talc is extensively used in animal feed. It wraps each feed particle, setting up a natural barrier that stops moisture escaping from or entering the treated feed. Talc also improves the fluidity of the material, which helps to keep equipment clean (minimising bacteria proliferation), lowers energy consumption, reduces production stoppages, and makes the job of operators safer.

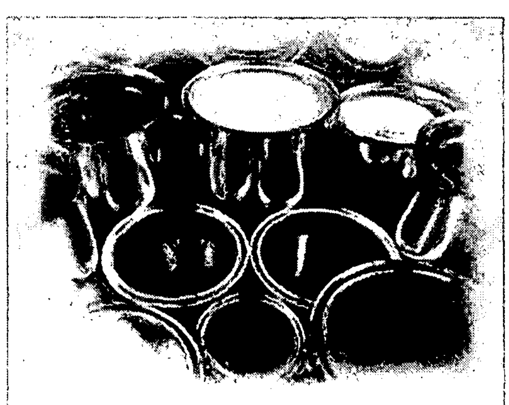


Lubricant

Talc is used as a lubricant, e.g. in pharmaceuticals. Besides having no reactivity with active ingredients, it facilitates the ingestion of solid drugs (pills, powders, etc). Talc also facilitates moulding/de-moulding of pills. It is widely used as a lubricant in dry materials transport.

Carrier

The chemical inertness of talc is of obvious interest for carrier applications. Excipients in pharmaceuticals and cosmetics (dry or moist) are a classic example. Apart from its inertnesss, talc also has the advantage of not generating bacterial growth and of releasing progressively the fragrances. Carriers are also critical in applications such as fertilisers and plant protection. Adding talc to active ingredients results in a well managed release, allowing the practical and safe handling of very small and very large quantities of active substances.

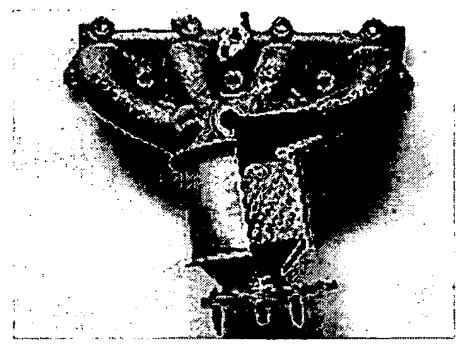


Thickener

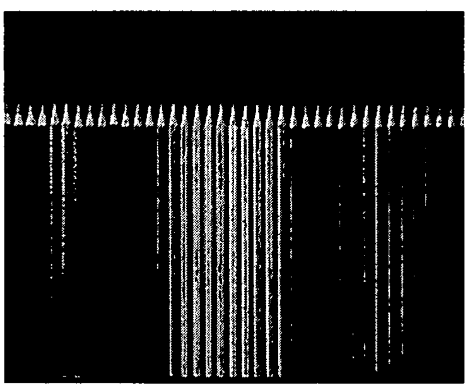
Talc is able to influence the viscosity of water-and solvent-based formulations. In paints for example, it increases the covering power, improves flow and stops settling. It also improves the adhesion and final mechanical properties of the coating. Talc enables paints, with the necessary low viscosities, to be formulated with significantly less organic solvents. The use of talc in the formulation of a range of liquid products (paint, cosmetics, glues, etc.) also contributes to controlling sedimentation

rates when they are stocked.

Strengthener



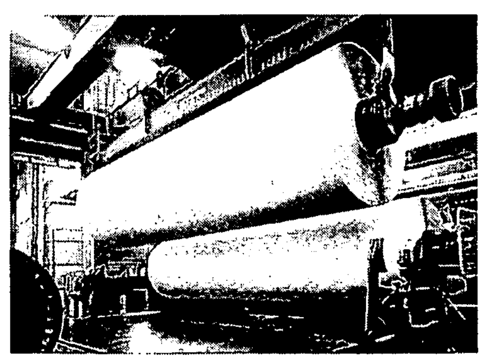
Talc is used to reinforce various types of resins, principally polypropylene (PP). Although the talc used in such applications is finely ground, it nevertheless maintains its lamellar structure. This gives the PP the best trade-off between rigidity and impact strength. Applications include domestic appliances, food packaging films and, above all, automotive components such as bumpers and dashboards. Talc is also used as a semi-reinforcing filler in rubber. Talc's properties bring benefits to ceramics (household, construction, refractory and technical). It reduces firing time and temperature, improves vitrification and consequently the resistance of the ceramic. It also improves thermal shock resistance, particularly important in catalytic exhausts.



Smooth filler

Talc's smoothness is appreciated in products that require suppleness and smoothness. A typical example is colouring pencils which, for a smooth and regular effect, must be robust, but at the same time softer than the paper. By volume, talc is also the principal ingredient of putties, particularly polyester putties where it improves adhesion and sandability.

Adsorbent



Talc's adsorption properties (i.e. adsorbing onto the surface only) are key in a number of applications: pitch control in paper making. Talc is used to adsorb organic impurities (pitch, unwanted anions) which are sticky. It also greatly improves runnability. As a filler in paper, it also increases smoothness and machinability, reduces friction, abrasion and porosity. In paper coating, it helps to improve ink transfer, finish feel and legibility of printing. Talc's

adsorption properties are also valuable in the treatment of waste water by the activated sludge method. Providing an adequate support surface, talc platelets actually "ballast" the bacteria used in such treatments, thereby improving sedimentation and avoiding the release of bacteria in the final clean effluent.

Registry numbers

The following table gives a non-exhaustive list of the main registries in which talc and chlorite are listed. Depending on the registries, substances may be given an inventory number or simply be listed.

	Talc	Chlorite
CAS	14807-96-6	1318-59-8
EINECS	238-877-9	215-285-9
AICS (Australia)	yes	no
CEPA (DSL/NDSL) (Canada)	yes (DSL)	yes (DSL)
ECL Serial N° (Korea)	1-686	9312-1666
ENCS/MITI (Japan)	no	no
NEPA (China)	-	-
PICCS (Phillipines)	yes	yes
TSCA (USA)	yes	yes

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